

AD-A174 774

Research Product 84-24

HUMAN FACTORS, MANPOWER, PERSONNEL  
AND TRAINING CLAUSES FOR THE CONCEPT  
EXPLORATION AND THE DEMONSTRATION  
AND VALIDATION REQUESTS FOR PROPOSAL

Systems Manning Technical Area  
Systems Research Laboratory

December 1984

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARI Research Product 84-24	2. GOVT ACCESSION NO. <b>ADA174774</b>	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) HUMAN FACTORS, MANPOWER, PERSONNEL, AND TRAINING CLAUSES FOR THE CONCEPT EXPLORATION AND THE DEMONSTRATION AND VALIDATION REQUESTS FOR PROPOSAL		5. TYPE OF REPORT & PERIOD COVERED Final July 1983 - August 1984
7. AUTHOR(s) W. P. Cherry (VRI), David M. Promisel and John L. Miles, Jr. (ARI)		6. PERFORMING ORG. REPORT NUMBER --
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		8. CONTRACT OR GRANT NUMBER(s) --
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63731A, 2Q263731A792
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) --		12. REPORT DATE December 1984
		13. NUMBER OF PAGES
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)  -- fr. back		
18. SUPPLEMENTARY NOTES  Dr. W. P. Cherry is affiliated with Vector Research, Inc., who provided support for the development of this product under Contract No. MDA903-81-C-0579.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Human factors <del>System performance</del> Mission analysis, Manpower <del>System requirements,</del> Soldier performance Personnel      System effectiveness,      Trade-off analysis. ← Training      Reverse engineering,      Proposal evaluation		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) → This document contains two sets of model statement of work (SOW) clauses, proposal evaluation factors, and a proposed data item description (DID) for the inclusion of human factors, manpower, personnel, and training (HMPT) in requests for proposal (RFPs) for the development of Army weapon systems. One set is for the concept exploration phase of the Life Cycle System Management Model for Army Systems, and the other for the demonstration and validation phase. The purpose of each set is to advise potential offerors of (Continued)		

DD FORM 1473

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UNCLASSIFIED

1 SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. (Continued)

Keywords: → to FLD 19

[illegible]

Research Product 84-24

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AND VALIDATION REQUESTS FOR PROPOSAL**

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**December 1984**

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**Army Project Number  
2Q263731A792**

**Manpower and Personnel**

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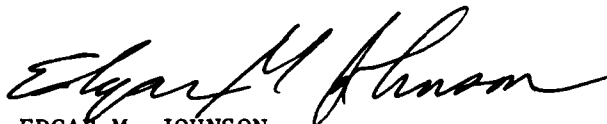
## FOREWORD

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The Army's weapon system acquisition process has been designed to include human factors, manpower, personnel, and training (HMPT) considerations in a comprehensive and timely fashion. However, this intent has not always been realized. Recently, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has been undertaking a series of special studies in response to a request by General Maxwell Thurman, now Vice Chief of Staff, who has been particularly concerned about HMPT issues in system design.

One study involved a "reverse engineering" analysis of the development of four specific systems to identify how and where to influence the acquisition process to achieve effective use of soldiers in weapon systems. A principal outcome was to confirm the need for the Army to prepare (1) system requirements documents that are more comprehensive with regard to HMPT objectives and constraints; and (2) system contractual documents that are more informative and explicit in terms of the role HMPT considerations must play in system design. This ARI Research Product is an outgrowth of these findings. It contains clauses for inclusion by the Army Materiel Command in requests for proposal for the concept exploration and demonstration and validation phases of the system development cycle. A companion ARI Research Product, No. RP 84-23, provides specific modifications to the format for the Required Operational Capability statement that now appears in AR 71-9 and the Materiel Acquisition Handbook, DARCOM/TRADOC Pamphlet 70-2.

ARI believes that these Research Products will be of immediate value to the Army. However, it is our intent to evaluate them through application to a sample of systems currently under development. The results of the evaluation will be incorporated in revisions to the documents.



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HUMAN FACTORS, MANPOWER, PERSONNEL, AND TRAINING CLAUSES FOR THE CONCEPT  
EXPLORATION AND THE DEMONSTRATION AND VALIDATION REQUESTS FOR PROPOSAL

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## INTRODUCTION

The following material is intended to serve as a basis for specifying the Human Factors, Manpower, Personnel and Training (HMPT) tasks of a Concept Exploration (CE) or a Demonstration and Validation (D&V) RFP. It includes prototypical Task Statement, Evaluation Criteria, Deliverables List and DID. It may be necessary to tailor all or parts of the material for specific systems.

The HMPT clauses for the CE and D&V RFP's are presented separately because, for many development programs, there is no CE contract. Where there has been a CE contract using HMPT clauses, the D&V material should be modified to avoid redundant activity. In many cases, merely updating and verifying the continuing validity of the HMPT work performed in the CE phase will be adequate.

The tasks defined in the Task Statement conform to a general hardware and software design paradigm used in previous RFPs. The tasks are intended to ensure proper consideration of HMPT early in the weapon system acquisition process and to develop information which will enable the Army to be confident that the system will meet required levels of performance using available and constrained levels of manpower, personnel and training resources.

Use of this material requires that a number of actions be completed prior to or during preparation of the RFP, including:

- Preparation of MPT Constraints.

The MPT constraints tell the contractor the numbers and quality of soldiers available to perform various roles in operation, maintenance and repair as well as the training time and resources available. It is intended that these numbers be derived from a total force analysis, i.e., one that considers the "faces" and "spaces" in the current and future Army that can be assigned to the new system and the impact of that assignment in terms of systems, branches and the Army as a whole. It is TRADOC's responsibility to conduct the force structure and total force analyses which produce MPT constraints and to make the analyses available to AMC and its contractors.

- Preparation of System Performance Requirements

System performance requirements need to be stated in terms of desired distributions of performance to reflect the range of characteristics of the pool of soldiers from which operators, maintainers and repairers must be drawn. Requirements should be expressed in this style:

For any system performance requirement, stated in terms of a given, fixed setting,

"- the level of performance,  $m_1$ , must be achieved or exceeded at least  $x_1$  percent of the time when system manning is drawn from the designated pool of soldiers..."

At least three sets of values should be stated for each system performance requirement representing:

- a minimum level of system performance to be achieved 95% of the time;
- a mean level of system performance;
- a superior level of system performance to be achieved at least 5% of the time.

- Preparation of Guidelines for Sensitivity Analyses

The contractor will be required to analyze his Best Technical Approach (BTA) to determine the impact of increased or decreased numbers of soldiers, improved or degraded quality mixes and increased or decreased training. In essence the contractor is conducting a "design to MPT" process and is asked to demonstrate the sensitivity of his BTA to tighter or looser constraints. Guidance on setting these increases or decreases, taken alone or in combination, should come from the Total Force Analysis and is thus the responsibility of the proponent. Care must be taken to consider the numbers involved, e.g., the impact of a 10 percent increase in a pool of 3000 soldiers may differ significantly from a 10 percent increase in a pool of 400.

## HMPT CLAUSES FOR CONCEPT EXPLORATION RFP

TASK \_\_\_\_: HUMAN FACTORS, MANPOWER, PERSONNEL, AND TRAINING

### Background

As the Army modernizes with high-technology hardware, it must ensure that it can man new equipment. In the past, system performance requirements presented in requirements documents have not always been met by all soldiers operating, maintaining, and repairing the system in the field. The Army believes that previously developed materiel systems have not performed in the field as desired because these systems were not designed with adequate consideration of the performance capabilities and limitations of their operators, maintainers and repairers. The goal of human factors, manpower, personnel, and training (HMPT) analysis early in the acquisition process is to ensure that system performance requirements will be met or exceeded by virtually all soldiers under all conditions. The purpose of this task is to assure that HMPT considerations are adequately addressed during concept exploration. Further background information concerning the need for and nature of HMPT analysis will be described in an HMPT briefing to potential bidders.

The requirements-driven acquisition process has as its goal the provision of a specified operational capability to the Army in the field subject to budgetary and schedule constraints or objectives. Implicit in this process is the fact that an operational capability derives from the engineering or

technical parameters of a system, the role and performance of the soldiers that operate, maintain and repair the system, and the resources required to recruit, train, and maintain those soldiers over the life of the system. All of these factors must be considered in the materiel acquisition process, particularly when making estimates of system performance to support design tradeoffs or program decisions.

The performance levels of hardware and software components of a system, in a given setting, are predictable with a relatively high degree of certainty. However, performance levels of soldier tasks or sets of tasks exhibit significant variation. Repeated trials by individual soldiers will result in a range of task performance levels for which mean values and variances can be determined; similar trials by different soldiers will lead to different mean values and variances. These differences are due to inherent differences in soldier aptitudes. Once a system design is fixed, it is the distribution of aptitudes translated through training into a distribution of task performance levels, that determine system performance, i.e., system performance levels can be expected to vary because of dependence on soldier task performance.

It is the intent of the Army that the level and variation of soldier physical characteristics and aptitudes be explicitly considered in the system design process. Accordingly a description of the pool of soldiers expected to be available as operators, maintainers and repairers has been prepared. The description provides details of numbers available, selected physical capabilities and distributions of aptitudes. Constraints on available training time and training resources are also defined.

It is intended that both the distribution of aptitudes and the degree to which levels of capability can be achieved through training be considered in defining the tasks and sets of tasks which operators, maintainers, and repairers must perform, and in setting the task performance standards necessary to meet system performance requirements. Section \_\_\_\_ of this RFP presents system performance requirements. Task \_\_\_\_ of this Statement of Work requires: (1) identification of the functions which must be performed by the soldier-machine system; (2) for each function identified, indication of the principal conditions (e.g., type of threat, climatic, light-level, NBC, etc.) under which the system must perform; and (3) for each function and accompanying set of conditions, determination of quantitative performance requirements.

In performing the required HMPT analyses, the contractor may use existing methodologies such as Early Comparability Analysis (ECA) and HARDMAN, tests designed and administered by the contractor, or other methods developed by the contractor. Copies of the ECA and HARDMAN handbooks will be provided by the Government for use by the contractor. All methods and data used by the contractor will be sufficiently documented that the Government can make an independent judgment as to the soundness of the methods, validity of any tests conducted, and realism of the results. While it is recognized that many design details will not be resolved during this early stage of the acquisition process, the HMPT analysis must proceed in parallel to and have the same scope and specificity as the hardware analysis which leads to the alternative design concepts.

### System Mission Analysis (SMA)

Functions which must be performed by the soldier-machine system are described by Task \_\_\_\_\_. For each separate design concept being considered by the contractor, functions allocated to personnel should be further analyzed to identify the specific tasks soldiers must perform to accomplish the function. Where the design concept is expressed in drawings, the tasks should be stated with reference to the likely hardware design; where there are no such drawings, the tasks may be stated notionally. The taxonomy for writing the tasks shall be the tri-service standard given in Amendment 2 to MIL-H-46855, dated 5 April 1984.

This analysis shall be documented in a written report.

### Task Performance Requirements Analysis (TPRA)

For each soldier performance task identified in the System Mission Analysis, the contractor shall derive performance requirements. The performance requirements for each task (1) shall be stated in terms of minimum acceptable accuracy and maximum acceptable time, (2) shall be derived from the system quantitative performance requirements and (3) shall be directly related to the metric to be used in the evaluation of system effectiveness. (These quantitative soldier performance requirements shall subsequently be used in both system analysis and system testing.)

The contractor shall also prepare a list of those tasks believed to be "high drivers;" (i.e., those tasks which are either critical\* to system performance and for which required task performance levels are believed difficult to achieve or for which required task performance frequency is

-----  
\* See para 6.2.1 of MIL-H-46855

uncertain and may have a major impact on manpower levels). Subsequent analysis will be performed on all tasks, but will emphasize these high drivers, e.g., examination of the design concepts for selection of the BTA in Task \_\_\_\_\_ will focus on the high drivers.

This analysis shall be documented in a written report.

Manpower, Personnel and Training Requirements Analysis (MPTRA)

Trade-off Analysis (TOA) shall be performed to identify alternative design concepts that maximize task and system performance levels. Two kinds of tradeoffs will be considered: MPT tradeoffs and soldier/machine tradeoffs. MPT tradeoffs will be conducted within the overall limits previously established for personnel and training resources. The contractor shall trade off numbers of personnel, personnel quality mix, and training resources to cause task performance capabilities to be as close as possible to task performance requirements. In performing these tradeoffs, the contractor shall not violate any restrictions on the use of female soldiers. Soldier/machine tradeoffs will identify tasks which can be shifted from personnel to hardware/software or for which the soldier/machine interface can be improved so as either to (1) improve task performance capabilities or (2) reduce the complexity of soldier task performance requirements without reducing system performance.

For the design concepts selected on the basis of the TOA the contractor shall perform a Manpower, Personnel and Training Requirements Analysis (MPTRA) to identify the number of operators, maintainers, and repairers (by likely MOS and grade), and training time needed to field the system in the



numbers and organizational structure specified by the O&O plan. As input to the MPTRA, the Government has prepared manpower, personnel and training constraints. These constraints reflect a force structure analysis. The constraints are presented in Exhibit 1 and represent limits on the personnel and training time available for operators, maintainers, and repairers of the new system. A detailed presentation of the derivation of the constraints is available from the Government. The Government has also developed and will supply a Target Audience Description and a preliminary training assessment to provide additional detail. The contractor will provide the results of the MPTRA for each design concept in the formats shown in Exhibits 2 and 3.

This analysis shall be documented in a written report.

#### Task Performance Capability Analysis (TPCA)

The contractor shall demonstrate the extent to which the task performance requirements identified in the TPRA can be met with the Army personnel and training resources projected by the MPTRA for the selected system concepts. The contractor shall perform a Task Performance Capability Analysis (TPCA) to estimate the distributions of task performance levels that can be expected of the different categories of personnel with their associated training times as identified in the MPTRA (reflecting the personnel quality levels shown in Exhibit 1). The contractor shall compare the results with the task performance requirements identified in the TPRA and determine the risk of disparity between soldier task performance capabilities and task requirements. Exhibit 4 illustrates one possible format for presenting the results of the TPCA for each design concept.

This analysis shall be documented in a written report.

### System Performance Estimation (SPE)

The contractor shall use the task performance capabilities derived in the TPCA to estimate the distribution of system performance for each of the system performance requirements. The contractor shall combine the data describing the distribution of available personnel by MOS and quality from the MPTRA, the task performance capability levels derived in the TPCA, and the task inventory developed in the SMA to predict the distribution of system performance levels expected to be achieved in the field. This will be done for each system performance requirement in each of the contractor's selected design concepts.

The contractor shall compare these results with the required system performance levels described in Section \_\_\_\_ of this RFP. Exhibit 5 illustrates one possible format for presenting these results. Shown are the Government requirements and the performance expected of each of the design concepts identified by the TOA. The alternative concepts may reflect different choices from among the MPT and soldier/machine tradeoffs but should all result in similar anticipated system performance levels. These results will serve as input in the evaluation of the design concepts for selecting the contractor's BTA in Task \_\_\_\_.

This analysis shall be documented in a written report.

#### MPT Sensitivity Analysis (MSA)

Following selection of the contractor's BTA, an MPT sensitivity analysis will be performed on the corresponding design concept. In particular, the contractor shall describe the impact of changes in the personnel and training constraints in Exhibit 1 on the distribution of task performance capabilities and resultant system performance levels. Similarly, the contractor shall identify those tasks for which changes in required frequency of performance would lead to increases or decreases in manpower requirements and/or system availability because of manpower constraints. Exhibit 6 presents guidelines and limits within which the sensitivity analysis will be conducted. Results of the sensitivity analysis will be presented in the same formats as the foregoing analyses.

This analysis shall be documented in a written report.

#### Soldier-Machine Interface (SMI) Design Approach Document (SDAP)

The SDAP shall identify for each design concept submitted the hardware locations where there is a soldier-machine interface, and for each such location shall identify the human engineering design considerations applied with respect to:

- a. Layout and arrangement
- b. Controls and displays
- c. Soldier vision
- d. Environmental factors (noise, vibration, fumes, temperature and radiation)
- e. Ingress, egress and access
- f. Storage of soldier gear (if applicable)

The SDAP shall be prepared in writing.

Consolidated HMPT Report

The contractor will prepare a consolidated HMPT Report in accordance with DI-H-0001 (PROV). The report will include the results of the above analyses, a description of approach and methods used, and a presentation and discussion of HMPT-related risk that system performance requirements will not be achieved within constraints. High driver and critical tasks will be identified and the impact of failing to meet soldier task requirements will be presented.

EXHIBIT 1: MPT CONSTRAINTS

TOTAL PERSONNEL

OFFICER	WO	EM	CIV
01	1	1-4	--
02	2	5	--
03	3	6	--
04	4	7	--
.		8	.
.		9	.
.			.

Grades

ENLISTED QUALITY AND TRAINING

MOS	QUALITY (percent of MOS)				TRAINING TIMES (by grade)
	I-III A	III B	IV		
MOS					
MOS					
MOS					
MOS					
MOS					
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

EXHIBIT 2: FORMAT FOR PRESENTING MPT DATA -- TOTAL FORCE REQUIREMENTS

SSI/MOS Title	SSI/MOS by Grade	Number Required	Estimated Training Times
Operators			
Maintainers			
Repairers			

Note: Should contractor believe a new MOS is required, it will be shown as MOS \_\_X\_\_. The first two digits of the currently existing MOS will precede the X.

# EXHIBIT 3: FORMAT FOR WORKLOAD DATA DISPLAY

System	MTBF	MTTR	DAMMH *						AMMH *					
			MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS
Sub-System														
-														
-														
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Sub-System														
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Sub-System														
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-														

\* NOTE: Data should be coded as follows:  
 E - Engineering Estimate  
 M - Empirical Data  
 S - Approved SDC Data

# EXHIBIT 4: EXAMPLE FORMAT FOR PRESENTING TASK PERFORMANCE CAPABILITY

Task: \_\_\_\_\_

Task Performance Measure: \_\_\_\_\_

Task Performance Requirement: \_\_\_\_\_

Soldier Category	Percent Soldiers Achieving Equal or Better					
	95	60	50	40	5	
AFQT I-III A						
AFQT III B						
AFQT IV						

Expected Task Performance Levels by Category



# EXHIBIT 5: SYSTEM PERFORMANCE FORMAT

System Performance Requirement: \_\_\_\_\_

	Required Performance Level	Performance Expected of Alternative Design Concepts				
		a	b	.	.	.
M5	—	—	—	.	.	.
M50	—	—	—	.	.	.
M95	—	—	—	.	.	.

# EXHIBIT 6: GUIDELINES AND LIMITS FOR SENSITIVITY ANALYSIS<sup>1</sup>

Type of Information	Maximum Increase <sup>2</sup>	Maximum Decrease <sup>2</sup>
Total personnel	_____ %	_____ %
Fraction of total personnel in AFQT categories I-III A	_____ %	_____ %
Fraction of total personnel in AFQT category IV	_____ %	_____ %
Training time per person	_____ %	_____ %

<sup>1</sup>In addition to the guidelines in the table, the contractor should assume that no increase in personnel is possible for any of the following critical MOS: \_\_\_\_\_.

<sup>2</sup>Maximum increase and decrease is with respect to data in exhibit 9.

SUMMARY OF HMPT PRODUCTS FROM CE CONTRACT

1. Interim (Letter) Reports:

- a. System Mission Analysis Report
- b. Task Performance Requirements Analysis Report
- c. Manpower, Personnel and Training Requirements Analysis Report
- d. Task Performance Capability Analysis Report
- e. System Performance Estimation
- f. MP&T Sensitivity Analysis Report
- g. SMI Design Approach Document

2. Deliverable Final Report:

DI-H-0001 (PROV) Consolidated HMPT Report

SOLICITATION NO. \_\_\_\_\_ PAGE NO. \_\_\_\_\_ CONTRACT NO. \_\_\_\_\_

SECTION \_\_\_\_: EVALUATION FACTORS FOR AWARD

\_\_\_-1 The factors to be evaluated are: Technical Approach; Understanding of the Problem; Human Factors, Manpower, Personnel, and Training; Integrated Logistic Support; Life Cycle Cost; and Management and Price. Technical Approach and Human Factors, Manpower, Personnel and Training are equal and most important. Integrated Logistic Support and Life Cycle Cost are equal but of less importance than Technical and HMPT. Understanding of the Problem and Management and Price are equal but of less importance than the other factors.

\_\_\_-2 In all of the aforementioned factors, significant consideration will be given to the contractor's recognition of and response to the fact that HMPT constraints constitute a major problem as the Army develops, fields, and operates systems. In particular, consideration will be given to the contractor's ability to define and clarify relevant HMPT issues and to demonstrate how these issues will be integrated in his design process; including system design, ILS, and Life Cycle Cost.

\_\_\_-XX Human Factors, Manpower, Personnel and Training (HMPT)

The evaluation elements for this factor are all of equal weight and include: Problem Understanding, Analysis, Integration, and Identification of Risk and its Impact.

a. Problem Understanding

1. The contractor's understanding of the nature of the HMPT problems in previous materiel development programs and as constraints imposed from the perspective of the total force will be evaluated.

2. The contractor's understanding of the nature and role of the HMPT data provided for this development (RFP section \_\_\_\_ ) will be evaluated.

SOLICITATION NO. \_\_\_\_\_ PAGE NO. \_\_\_\_\_ CONTRACT NO. \_\_\_\_\_

SECTION \_\_\_\_\_ - EVALUATION FACTORS FOR AWARD

\_\_\_\_-XX Human Factors, Manpower, Personnel and Training (Continued)

b. Analysis

1. The adequacy of the proposed procedures to generate data to support HMPT analyses will be evaluated. These data include, for example, task requirements data, task performance data, quality-training-skill level data, task loading data, training time, etc.

2. The adequacy of the approach proposed to relate human factors, manpower, personnel and training parameters to system requirements, including performance, maintenance and support, will be evaluated.

3. The adequacy of the approach proposed to conduct trade-off analyses of HMPT parameters and hardware/software design parameters to improve system performance will be evaluated.

4. The adequacy of the approach proposed to conduct sensitivity analyses relating design alternatives and effectiveness to varying manpower, personnel and training constraint levels will be evaluated.

c. Integration

1. The adequacy of the contractor's approach to integrating manpower, personnel and training alternatives, constraints, and analysis results into the system development will be evaluated.

2. The means and procedures proposed by the contractor to document and report HMPT tradeoff analyses and design implications will be evaluated.

d. Identification of Risk and Impact

1. The approach proposed to identify risk in system designs relative to human factors, manpower, personnel and training parameters will be evaluated.

2. The approach proposed to estimate and describe the potential impact of risk in system design attributes relative to system effectiveness and human factors, manpower, personnel, and training constraints will be evaluated.

3. Procedures proposed to test, estimate or otherwise check parameter values used in human factors, manpower, personnel and training estimates and thus reduce risk will be evaluated.

4. The contractor's approach to prioritizing and designing tests or effort focusing on HMPT uncertainty or risk for follow-on development will be evaluated.

## DATA ITEM DESCRIPTION

TITLE		AGENCY	NUMBER
Consolidated Human Factors, Manpower, Personnel and Training Final Report (CE Phase)		Army	DI-H-0001 (PROV)
3. DESCRIPTION PURPOSE.			
<p>3.1 This DID identifies the content and format requirements of the final report (CE Phase) of the human factors, manpower, personnel and training tasks described in the scope of work of the contract.</p> <p>3.2 This report describes the contractor's system from the viewpoint of human factors, manpower, personnel and training, defines and quantifies risks related to HMPT which affect system performance and availability, and includes final versions of reports related to HMPT analyses.</p>			
4. APPROVAL DATE	5. OFFICE OF PRIMARY RESPONSIBILITY	6. DTIC REQUIRED	
1984 SEP 06	A/PERI-SM	X	
7. APPLICATION INTERRELATIONSHIP			
<p>7.1 This DID is applicable to R&amp;D contracts for system development in the concept exploration phase of the Life Cycle System Management Model for Army Systems (DA Pamphlet 11-25).</p> <p>7.2 This DID may be used instead of DI-H-7053 through DI-H-7057.</p> <p>7.3 This DID contains the final versions of HMPT interim (letter) reports required by the HMPT Task in the Scope of Work of the contract.</p>			
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<p>10.1 This report shall be prepared in accordance with the requirements stated in MIL-STD-847.</p> <p>10.2 The report shall be in narrative style with illustrations and photographs where necessary to aid the reader's understanding of what is being explained.</p> <p>10.3 The report shall contain:</p> <ol style="list-style-type: none"> <li>Executive Summary</li> <li>DD Form 1473</li> <li>Introduction</li> <li>Final Reports of <ol style="list-style-type: none"> <li>System Mission Analysis</li> <li>Task Performance Requirements Analysis</li> <li>Manpower, Personnel and Training Requirements Analysis</li> <li>Task Performance Capability Analysis</li> <li>System Performance Estimation</li> <li>MP&amp;T Sensitivity Analysis</li> <li>Soldier-Machine Interface Design Approach Document</li> </ol> </li> </ol>			

## HMPT CLAUSES FOR DEMONSTRATION AND VALIDATION RFP

TASK \_\_\_\_: HUMAN FACTORS, MANPOWER, PERSONNEL, AND TRAINING

### Background

As the Army modernizes with high-technology hardware, it must ensure that it can man new equipment. In the past, system performance requirements presented in requirements documents have not always been met by all soldiers operating, maintaining, and repairing the system in the field. The Army believes that previously developed materiel systems have not performed in the field as desired because these systems were not designed with adequate consideration of the performance capabilities and limitations of their operators, maintainers and repairers. The goal of human factors, manpower, personnel, and training (HMPT) analysis early in the acquisition process is to ensure that system performance requirements will be met or exceeded by virtually all soldiers under all conditions. The purpose of this task is to assure that HMPT considerations are adequately addressed during demonstration and validation. Further background information concerning the need for and nature of HMPT analysis will be described in an HMPT briefing to potential bidders.

The requirements-driven acquisition process has as its goal the provision of a specified operational capability to the Army in the field subject to budgetary and schedule constraints or objectives. Implicit in this process is the fact that an operational capability derives from the engineering or technical parameters of a system, the role and performance of the soldiers



that operate, maintain and repair the system, and the resources required to recruit, train, and maintain those soldiers over the life of the system. All of these factors must be considered in the materiel acquisition process, particularly when making estimates of system performance to support design tradeoffs or program decisions.

The performance levels of hardware and software components of a system, in a given setting, are predictable with a relatively high degree of certainty. However, performance levels of soldier tasks or sets of tasks exhibit significant variation. Repeated trials by individual soldiers will result in a range of task performance levels for which mean values and variances can be determined; similar trials by different soldiers will lead to different mean values and variances. These differences are due to inherent differences in soldier aptitudes. Once a system design is fixed, it is the distribution of aptitudes translated through training into a distribution of task performance levels, that determine system performance, i.e., system performance levels can be expected to vary because of dependence on soldier task performance.

It is the intent of the Army that the level and variation of soldier physical characteristics and aptitudes be explicitly considered in the system design process. Accordingly a description of the pool of soldiers expected to be available as operators, maintainers and repairers has been prepared. The description provides details of numbers available, selected physical capabilities and distributions of aptitudes. Constraints on available training time and training resources are also defined.

It is intended that both the distribution of aptitudes and the degree to which levels of capability can be achieved through training be considered in defining the tasks and sets of tasks which operators, maintainers, and repairers must perform, and in setting the task performance standards necessary to meet system performance requirements. Section \_\_\_\_\_ of this RFP presents system performance requirements. Task \_\_\_\_\_ of this Statement of Work requires: (1) identification of the functions which must be performed by the soldier-machine system; (2) for each function identified, indication of the principal conditions (e.g., type of threat, climatic, light-level, NBC, etc.) under which the system must perform; and (3) for each function and accompanying set of conditions, determination of quantitative performance requirements.

In performing the required HMPT analyses, standard methodologies, tests designed and administered by the contractor or other methods developed by the contractor may be used. All methods and data used will be sufficiently documented by the contractor that the Government can make an independent judgment as to the soundness of the methods, validity of any tests conducted, and realism of the results. While it is recognized that some design details will not yet be resolved at this stage of the acquisition process, the HMPT analysis must proceed in parallel to, and have the same scope and specificity as, the hardware analysis which leads to the alternative detailed designs.

### System Mission Analysis (SMA)

Functions which must be performed by the soldier-machine system are described by Task \_\_\_\_\_. For each detailed design being developed by the contractor, functions allocated to personnel should be further analyzed to identify the specific tasks soldiers must perform to accomplish the function. As the design is expressed in drawings, the tasks should be stated with reference to the hardware; before the drawings are prepared, the tasks may be stated notionally. The taxonomy for writing the tasks shall be the tri-service standard given in Amendment 2 to MIL-H-46855, dated 5 April 1984.

This analysis shall be documented in a written report.

### Task Performance Requirements Analysis (TPRA)

For each soldier performance task identified in the System Mission Analysis, the contractor shall derive performance requirements. The performance requirements for each task (1) shall be stated in terms of minimum acceptable accuracy and maximum acceptable time, (2) shall be derived from the system quantitative performance requirements and (3) shall be directly related to the metric to be used in the evaluation of system effectiveness. (These quantitative soldier performance requirements shall subsequently be used in both system analysis and system testing.)

The contractor shall also prepare a list of those tasks believed to be "high drivers" (i.e., those tasks which are either critical\* to system performance and for which required task performance levels are believed difficult to achieve or for which required task performance frequency is

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\* See para 6.2.1 of MIL-H-46855

uncertain and may have a major impact on manpower levels.) Subsequent analysis will be performed on all tasks, but will emphasize these high drivers.

This analysis shall be documented in a written report.

Manpower, Personnel and Training Requirements Analysis (MPTRA)

Trade-off Analysis (TOA) shall be performed to identify alternative detailed designs that maximize task and system performance levels. (Note that the TOA may produce only one design that provides the required performance.) Two kinds of tradeoffs will be considered: MPT tradeoffs and soldier/machine tradeoffs. MPT tradeoffs will be conducted within the overall limits previously established for personnel and training resources. The contractor shall trade off numbers of personnel, personnel quality mix, and training resources to cause task performance capabilities to be as close as possible to task performance requirements. In performing these tradeoffs, the contractor shall not violate any restrictions on the use of female soldiers. Soldier/machine tradeoffs will identify tasks which can be shifted from personnel to hardware/software or for which the soldier/machine interface can be improved so as either to (1) improve task performance capabilities or (2) reduce the complexity of soldier task performance requirements without reducing system performance.

For the alternative detailed designs selected on the basis of the TOA the contractor shall perform a Manpower, Personnel and Training Requirements Analysis (MPTRA) to identify the number of operators, maintainers, and repairers (by likely MOS and grade), and training time needed to field the system in the numbers and organizational structure specified by the O&O plan. As input to the MPTRA, the Government has prepared manpower, personnel and

training constraints. These constraints reflect a force structure analysis. The constraints are presented in Exhibit 1 and represent limits on the personnel and training time available for operators, maintainers, and repairers of the new system. A detailed presentation of the derivation of the constraints is available from the Government. The Government has also developed and will supply a Target Audience Description and a preliminary training assessment to provide additional detail. The contractor will provide the results of the MPTRA for each detailed design in the formats shown in Exhibits 2 and 3.

This analysis shall be documented in a written report.

#### Task Performance Capability Analysis (TPCA)

The contractor shall demonstrate the extent to which the task performance requirements identified in the TPRA can be met with the Army personnel and training resources projected by the MPTRA for the selected system designs. The contractor shall perform a Task Performance Capability Analysis (TPCA) to estimate the distributions of task performance levels that can be expected of the different categories of personnel with their associated training times as identified in the MPTRA (reflecting the personnel quality levels shown in Exhibit 1). Human engineering testing will be designed and conducted by the contractor to help establish and validate the task performance levels. The tests shall be conducted on at least those tasks previously identified as "high drivers". The contractor shall select, with approval by the Government, a representative sample of individuals who will be used as test subjects. The contractor shall compare the results with the task performance requirements identified in the TPRA and determine the risk of disparity

between soldier task performance capabilities and task requirements. Exhibit 4 illustrates one possible format for presenting the results of the TPCA for each detailed design.

This analysis shall be documented in a written report.

#### System Performance Estimation (SPE)

The contractor shall use the task performance capabilities derived in the TPCA to estimate the distribution of system performance for each of the system performance requirements. The contractor shall combine the data describing the distribution of available personnel by MOS and quality from the MPTRA, the task performance capability levels derived in the TPCA, and the task inventory developed in the SMA to predict the distribution of system performance levels expected to be achieved in the field. This will be done for each system performance requirement in each of the contractor's selected design concepts.

The contractor shall compare these results with system performance levels previously established by the Government in selecting the Best Technical Approach (BTA) during the concept exploration phase. Exhibit 5 illustrates one possible format for presenting these results. Shown are the Government requirements and the performance expected of each of the design concepts identified by the TOA. The alternative concepts may reflect different choices from among the MPT and soldier/machine tradeoffs but should all result in similar anticipated system performance levels. The contractor may not make a final selection of design concept and complete his design until authorized to do so by the Government.

This analysis shall be documented in a written report.

#### MPT Sensitivity Analysis (MSA)

Following finalization of the contractor's hardware and software design, an MPT sensitivity analysis will be conducted on this design. In particular, the contractor shall describe the impact of changes in the personnel and training constraints in Exhibit 1 on the distribution of task performance capabilities and resultant system performance levels. Similarly, the contractor shall identify those tasks for which changes in required frequency of performance would lead to increases or decreases in manpower requirements or system availability because of manpower constraints. Exhibit 6 presents guidelines and limits within which the sensitivity analysis will be conducted. Results of the sensitivity analysis will be presented in the same formats as the foregoing analyses.

This analysis shall be documented in a written report.

#### Human Engineering and Performance Analysis (HEPA)

The purpose of this sub-task is to verify the feasibility of the required soldier performance, the accuracy of the aptitude level forecasts, the adequacy of the proposed training program, and the acceptability of the soldier-machine interfaces.

##### a. Soldier Performance

(1) The contractor shall conduct soldier performance measurement (SPM) on all tasks designated as "critical" (see para 6.2.1 of MIL-H-46855) for operations, maintenance and repair. SPM shall be conducted with no fewer than three individuals (i.e.,  $n = 3$  or more) performing (in turn) each task identified as critical. The three or more individuals selected will each

either (1) be present U.S. Army soldiers of the grade and MOS tentatively identified for the job to which each critical task will be assigned or, (2) if actual soldiers are not provided to the contractor for SPM, be persons of similar age, physical characteristics (including gender, if required) and ASVAB scores. The contractor shall relate the quantitative system performance requirements (developed in the SMA) to the performance requirements for each critical task (developed in the TPRA) such that variations in the quality (timeliness and accuracy) of soldier performance of critical tasks will affect the numerical value of the metric used to express system effectiveness. The contractor shall then gather soldier performance data by measuring the time and accuracy of that performance for each critical task. The environmental conditions (temperature, humidity, illumination, noise, ventilation and vibration) under which the data were gathered shall be reported, and a description (referenced to any existing engineering drawings) of the soldier-machine interface (SMI) shall be included.

(2) The soldier performance data shall be analyzed by both time and errors. Both the frequency and cause(s) of errors shall be reported and shall be supplemented (if appropriate) by explanations from participating soldiers of the reasons for their performance errors. Effects of measured soldier performance on the metric for system effectiveness shall be shown, and any projected decrements in system performance shall be explained.



b. Aptitude Levels

(1) The soldier performance data shall be analyzed by the ASVAB scores of the soldiers participating. Performance data shall be presented (1) by each ASVAB subtest score of each soldier participant and (2) by the cluster of ASVAB subtest scores used to make MOS assignments applicable to the system being developed.

(2) Analysis of these data will include an explanation of the expected probability that soldiers whose performance of critical tasks was adequate or better are representative of the soldiers who are the intended performers of those critical tasks.

c. Training Adequacy

(1) The training program administered to the participating soldiers by the contractor shall be analyzed for compliance with the constraints on cost and length of training. Any discrepancies shall be explained.

(2) Results of an end-of-training comprehension examination given to participating soldier immediately before SPM begins shall be reported and analyzed. The purpose of this examination is to determine whether, prior to performance for record, the soldier-participants correctly understood the details of what they were supposed to do.

(3) Analysis of these data will include an assessment of whether any submarginal soldier performance was caused by (1) lack of soldier-participant aptitude or (2) inability of the training program to produce the required performance from a person of adequate aptitude.

d. Soldier-Machine Interface (SMI)

(1) The contractor shall propose for this system a human engineering design guide from among those generally available. During the same time-frame of the SPM, the contractor shall prepare an evaluation of the hardware and software in the SMI of his system, based on compliance with the human engineering guide he proposed. This evaluation may be supplemented by statements from SPM participants concerning reasons for their performance errors and their subjective judgments concerning the layout and accessibility of controls and displays and the design of software.

(2) A narrative description (supplemented by photographs or illustrations, if appropriate) of any observed safety hazards during SPM shall be included.

(3) This analysis shall also include narrative explanations of and proposals for overcoming any:

(a) observed or reported incompatibility among tasks assigned to a single job;

(b) observed or reported incompatibility between tasks assigned to different members of the same crew; and

(c) observed or reported incompatibility between different items of equipment in the SMI.

#### Consolidated HMPT Report

The contractor will prepare a consolidated HMPT Report in accordance with DI-H-0002 (PROV). The report will include the results of the above analyses, a description of approach and methods used, and a presentation and discussion of HMPT related risk that system performance requirements will not be achieved within constraints. High driver and critical tasks will be identified and the impact of failing to meet soldier task requirements will be presented.

EXHIBIT 1: MPT CONSTRAINTS

TOTAL PERSONNEL

OFFICER	WO	EM	CIV
01	1	1-4	--
02	2	5	--
03	3	6	--
04	4	7	--
.		8	.
.		9	.
.			.

Grades

ENLISTED QUALITY AND TRAINING

MOS	QUALITY (percent of MOS)				TRAINING TIMES (by grade)
	I-III A	III B	IV		
MOS					
MOS					
MOS					
MOS					
MOS					
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

EXHIBIT 2: FORMAT FOR PRESENTING MPT DATA -- TOTAL FORCE REQUIREMENTS

SSI/MOS Title	SSI/MOS by Grade	Number Required	Estimated Training Times
Operators			
Maintainers			
Repairers			

Note: Should contractor believe a new MOS is required, it will be shown as MOS\_\_X. The first two digits of the currently existing MOS will precede the X.

# EXHIBIT 3: FORMAT FOR WORKLOAD DATA DISPLAY

System	MTBF	MTTR	DMMH *						AMMH *					
			MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS	MOS
Sub-System														
-														
-														
-														
Sub-System														
-														
-														
-														
Sub-System														
-														
-														
-														
Sub-System														
-														
-														
-														

\* NOTE: Data should be coded as follows:  
 E - Engineering Estimate  
 M - Empirical Data  
 S - Approved SDC Data

**EXHIBIT 4: EXAMPLE FORMAT FOR PRESENTING TASK PERFORMANCE CAPABILITY**

Task: \_\_\_\_\_

Task Performance Measure: \_\_\_\_\_

Task Performance Requirement: \_\_\_\_\_

Soldier Category	Percent Soldiers Achieving Equal or Better				
	95	60	50	40	5
AFQT I-III A					
AFQT III B					
AFQT IV					

**Expected Task Performance Levels by Category**

# EXHIBIT 5: SYSTEM PERFORMANCE FORMAT

System Performance Requirement: \_\_\_\_\_

	Required Performance Level	Performance Expected of Alternative Detailed Designs	
		a	b
M5	—	—	—
M50	—	—	—
M95	—	—	—



Type of Information	Maximum Increase <sup>2</sup>	Maximum Decrease <sup>2</sup>
Total personnel	_____ %	_____ %
Fraction of total personnel in AFQT categories I-III A	_____ %	_____ %
Fraction of total personnel in AFQT category IV	_____ %	_____ %
Training time per person	_____ %	_____ %

<sup>1</sup>In addition to the guidelines in the table, the contractor should assume that no increase in personnel is possible for any of the following critical MOS: \_\_\_\_\_.

<sup>2</sup>Maximum increase and decrease is with respect to data in exhibit 9.

SUMMARY OF HMPT PRODUCTS FROM D&V CONTRACT

1. Interim (Letter) Reports:

- a. System Mission Analysis Report
- b. Task Performance Requirements Analysis Report
- c. Manpower, Personnel and Training Requirements Analysis Report
- d. Task Performance Capability Analysis Report
- e. System Performance Estimation
- f. MP&T Sensitivity Analysis Report
- g. SMI Design Approach Document

2. Deliverable Final Report:

DI-H-0002 (PROV) Consolidated HMPT Report

SOLICITATION NO. \_\_\_\_\_ PAGE NO. \_\_\_\_\_ CONTRACT NO. \_\_\_\_\_

SECTION \_\_\_\_: EVALUATION FACTORS FOR AWARD

\_\_\_\_-1 The factors to be evaluated are Technical; Human Factors, Manpower, Personnel and Training; Integrated Logistic Support; Life Cycle Cost; and Management and Price. Technical and Human Factors, Manpower, Personnel and Training factors are of equal weight and are most important. Integrated Logistic Support and Life Cycle Cost are equal but of less importance than Technical and Human Factors, Manpower, Personnel and Training. Management and Price are equal but of less importance than other factors.

\_\_\_\_-2 In all of the aforementioned factors, significant consideration will be given to the contractor's ability and approach to integrating Human Factors, Manpower, Personnel and Training into his system development and his recognition of the importance of achieving or surpassing the HMPT objectives set out in the SOW.

\_\_\_\_-XX Human Factors, Manpower, Personnel and Training (HMPT)

The evaluation elements for this factor are all of equal weight and include: Preliminary System Design, Analysis, Integration and Identification of Risk and Impact.

a. Preliminary System Design

1. The adequacy of the contractor's preliminary design will be evaluated in terms of Human Factors, Manpower, Personnel and Training. Compliance with and response to the constraints and guidance provided in the SOW in section \_\_\_\_ will be evaluated.

2. The contractor's treatment of HMPT high driver and high risk tasks as identified in the SOW, section \_\_\_\_, will be evaluated. The adequacy of the contractor's approach to reducing the impact and risk of these tasks will be evaluated.

3. The adequacy of the contractor's identification of high risk and high driver tasks remaining in his design will be evaluated. The contractor's approach to focusing attention and resources on these tasks will be evaluated.

SOLICITATION NO. \_\_\_\_\_ PAGE NO. \_\_\_\_\_ CONTRACT NO. \_\_\_\_\_

SECTION \_\_\_\_ - EVALUATION FACTORS FOR AWARD

\_\_\_\_-XX Human Factors, Manpower, Personnel, and Training (HMPT) (Continued)

b. Analysis

1. The adequacy of the proposed procedures to generate data to support HMPT analyses will be evaluated. These data include, for example, task requirements data, task performance data, quality-training-skill level data, task loading data, training times, etc.

2. The adequacy of the approach proposed to relate human factors, manpower, personnel, and training parameters to system requirements, including performance, maintenance and support will be evaluated.

3. The adequacy of the approach proposed to conduct trade-off analyses of HMPT parameters and soldier/machine design parameters to improve system performance will be evaluated.

4. The adequacy of the approach proposed to conduct sensitivity analyses relating design alternatives and system performance effectiveness to varying human factors, manpower, personnel and training constraint levels will be evaluated.

c. Integration

1. The adequacy of the contractor's approach to integrating human factors, manpower, personnel and training alternatives, constraints, and analysis results into the system development will be evaluated.

2. The means and procedures proposed by the contractor to document and report HMPT tradeoff analyses and design implications will be evaluated.

d. Identification of Risk and Impact

1. The approach proposed to identify risk in system designs relative to human factors, manpower, personnel and training parameters will be evaluated.

2. The approach proposed to estimate and describe the potential impact of risk in system design attributes relative to system effectiveness and human factors, manpower, personnel and training constraints will be evaluated.

3. Procedures proposed to test, estimate or otherwise check parameter values used in human factors, manpower, personnel and training estimates and thus reduce risk will be evaluated.

4. The contractor's approach to prioritizing and designing tests or effort focusing on HMPT uncertainty or risk for follow-on development will be evaluated.

DATA ITEM DESCRIPTION		IDENTIFICATION NUMBER	
		AGENCY	NUMBER
1 TITLE Consolidated Human Factors, Manpower Personnel and Training Final Report: (D&V Phase)		Army	DI-H-0002 (PROV)
3 DESCRIPTION PURPOSE			
<p>3.1 This DID identifies the content and format requirements of the final report (D&amp;V Phase) of the human factors, manpower, personnel and training tasks described in the scope of work of the contract.</p> <p>3.2 This report describes the contractor's system from the viewpoint of human factors, manpower, personnel and training, states personnel performance proficiency related to measures of system effectiveness, and includes final versions of reports related to HMPT analyses.</p>			
4 APPROVAL DATE 1984 SEP 06	5 OFFICE OF PRIMARY RESPONSIBILITY A/PERI-SM	6 DTIC REQUIRED X	
7 APPLICATION INTERRELATIONSHIP			
<p>7.1 This DID is applicable to R&amp;D contracts for system development in the advanced development (D&amp;V) phase of the Life Cycle Management Model for Army Systems (DA Pamphlet 11-25).</p> <p>7.2 This DID may be used instead of DI-H-7053 through DI-H-7057.</p> <p>7.3 This DID contains the final versions of HMPT interim (letter) reports required by the HMPT Task in the Scope of Work of the contract.</p>			
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